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A COMPARATIVE STUDY OF THE EFFECT OF TWO TRAINING PROGRAMS ACCORDING TO THE CROSSFIT AND TABATA METHODS IN DEVELOPING SOME FUNCTIONAL AND BIOCHEMICAL VARIABLES FOR FEMALE FOOTBALL PLAYERS

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Abstract:
The aim of the research is to identify the effect of Tabata training and CrossFit training in developing some functional and biochemical variables for female football players. The study was conducted on Solaf Sports Club players registered with the Federation for the 2022/2023 sports season, aged (23.15 ± 6.35) years, weighing (77.08 ± 3.74) kg, and with a height of (178.12 ± 8.85) cm, totaling (24) players. They were distributed into two experimental groups with (12) players for each group. The first experimental group implemented Tabata training, while the second experimental group implemented CrossFit training. The two training programs were implemented on the study sample, where the duration of the implementation of the two programs was (12) weeks, with (3) training units per week, the duration of each training unit was (90) minutes, where the total number of units was (36) training units. The researchers used the (T-TEST) law for independent and independent samples to find out the difference between the pre-test and post-test and the post-test for both groups. It was concluded that both training methods made a noticeable development in the study variables, and there was a relative superiority of CrossFit training in improving functional and biochemical variables, indicating its effectiveness in improving aerobic and anaerobic performance, as well as supporting physical endurance and increasing physiological values associated with athletic performance.
Keywords: Tabata training, CrossFit training, functional variables, biochemical variables, football

Introduction:

Football is a team game that requires special training. This game requires high physical effort due to many changes in the size and level of physical effort exerted by the player during the course of the match for many reasons, including the difference in playing conditions and situations, the level of the opposing team, and sudden plans. All of this exposes the player to different physical efforts that increase the player's effort and weaken his physical ability and expose him to pressure on the physical, skillful, tactical and psychological levels. This places us in front of the need to understand the effect of physical effort and exercise on the body's functions to achieve the level of achievement and adapt to the requirements of the game, so that it makes the athlete resist fatigue despite the accumulation of amounts of lactic acid in the muscles and blood due to the lack of oxygen consumed as a result of the intensity of performance. **(Bangsbo., 1994)**.

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Professional football players usually cover a distance of 11-13 kilometers in each match, depending on the playing position, as midfielders cover the highest distances and defenders the least of the total distance covered **(Bradley, et al., 2009).** The 1150 m run is performed at speeds of over 20 km/h, with 60 sprints; this also depends on the playing position (Barnes et al., 2014). In general, football players perform more than 1200 unpredictable variable movements in play, which include about 700 turns and 30-40 jumps and tackles **(Bloomfield,m 2007**). Therefore, the football player must be well prepared and able to endure long periods of low to moderate intensity activity (i.e. endurance performance) and maintain periods of high intensity (explosive) performance. Accordingly, football is classified as a game that depends on the aerobic and anaerobic energy systems. The dominant energy system is the anaerobic energy system, which contributes 70% of the energy produced, while the aerobic energy system contributes 30% **(Powers, et al., 2001).** During running at maximum speed for 3 seconds, the phosphagen system (ATP-PCr) contributes about 65% of the energy needed **(Spencer et al., 2005),** while during running at maximum speed for 6 seconds, it contributes about 50% of the energy needed **(Girard et al., 2011).**

In this regard, many efforts have emerged to find alternatives and diverse and comprehensive training methods for physical and functional variables and motor skills in order to achieve and also to maintain health by many researchers and specialists in the field of sports, including (LISS CARDIO training, HIIT CARDIO training, aerobic training, Zumba training, TABATA training and CROSSFIT training).

(Talisa Emberts et al., 2013) see that Tabata training is a term often used synonymously with high-intensity interval training. These exercises began to appear after the year (1990) by the Japanese doctor Izumi Tabata, as he was looking for a way to enhance the condition of the Olympic skiing team, relying on the body without external effort or heavy weights. In the year (1996), Tabata and his colleagues conducted a study on the effect of continuous moderate-intensity training (170% of Vo2max) for (60) minutes, high-intensity interval training (170% of Vo2max). The most important results of the study were that high-intensity interval training developed aerobic capacity to a similar degree to continuous moderate-intensity training, but with an increase of (28%) in anaerobic capacity. **(Emberts, T. M. 2013)**

High-intensity interval training (HIIT) is a popular training method in recent years, and the Tabata method is one of the high-intensity interval training (HIIT) methods. The Tabata training method contains different forms of training performed during (10: 20 seconds), where the time period (20 seconds) is the time of performing the exercise and (10 seconds) is the rest period before performing the next exercise. **(Sumpena, D Z Sedic, 2017).**

This training method can be used for aerobic and anaerobic exercises, such as (squats, push-ups, jumping rope, and running in place). **(Christopher Scott, et al, 2015).**

(Yacup A, et al) indicate that there are some studies that have proven that the high-intensity interval training (HIIT) method has effective effects on the aerobic and anaerobic energy system. It was found that it improves the maximum oxygen consumption and mitochondrial enzyme activities to produce energy in skeletal muscles. **(Yacup A, et al, 2018).**

As for the CrossFit training method, it is one of the modern methods used in the training process, as the system of this method is "a mixture of aerobic exercises, body weight exercises, weightlifting exercises, gymnastics, Battle Rope exercises, and Ply soft Box exercises. **(Marwa Fathy, 2017),** and this type of training does not require a special field, and the nature of the performance, i.e. the method of performing this method, works to develop the special physical qualities of football players, which is positively reflected in the functional and biochemical variables as a result of the great diversity in exercises, which leads to the participation of a large and different group of muscle fibers and improving their efficiency to continue working according to the prevailing energy system for this activity, as "the purpose of training programs is to cause changes in the energy metabolism process and physiological changes according to the performance

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requirements that make athletes perform better in competitions, and despite the diversity of training methods and methods, it cannot be said that there is a single specific method or method that can be considered the best in training all multiple energy systems and achieving changes in them Equally. **(Mohamed Ali, 2005)**

Researchers see from the above that there are special abilities possessed by the football player that differ from other games represented by physical abilities such as explosive strength of the leg muscles, transitional speed, endurance, agility and flexibility, and thus depend on physiological measurements such as anaerobic capacity, heart rate, maximum oxygen consumption and fatigue, which affect physical and skill performance by choosing correct training methods based on measurements and tests to improve the physical and skill condition of the football player to reach the best results. The researchers noticed fluctuations in the level of performance among the players of Solaf Sports Club for football. With a close look at the club's level in local matches, we find that there is a kind of decline and instability in performance. The reason may be that most coaches focus on conducting training units with fixed and non-varied rhythms that lack modern methods in the physical preparation process, which negatively affects the functional aspect. In addition, there is a clear deficiency in physical and physiological measurements, which are important for mastering basic football skills. Hence, the importance of the research emerged in identifying the effect of Tabata training and CrossFit training, which are the latest and most widespread in many countries, in addition to developing the capabilities of coaches and helping them in inventing appropriate means to raise the levels of players and athletes and knowing their functional status during training and competition and following up on the various effects resulting from them. This study also contributes to expanding ideas about the physiological and biochemical responses of the body during sports activity and its adaptation to external conditions.

Procedures and measurements:

Participants:

The study was conducted on Solaf Sports Club players registered with the Federation for the 2022/2023 sports season, aged (23.15 ± 6.35) years, weighing (77.08 ± 3.74) kg, and with a height of (178.12 ± 8.85) cm, totaling (24) players. They were distributed into two experimental groups, with (12) players for each group. The first experimental group implemented Tabata training, while the second experimental group implemented CrossFit trainin

Procedures:

The anaerobic capacity of the lower limb muscles was measured using the Wingate Test and using a Swedish-made stationary bike (Monark E894) and its analysis program (Monark Anaerobic Test Software). The Winket test was performed for (30) seconds with a resistance of (0.075) grams per kilogram of body weight (Bar-Or, O. (1987)). Using the protocol for measuring anaerobic capacity for the Winket test, the heart rate after effort and the maximum oxygen consumption before and after effort were measured using the Fitmate MED device.

While the biochemical variables were measured using the CBC device, Hematclgy analyzer itaLy paramedic. As for the Lactate Dehydrogenase variable, it was measured using the BIOSYSTEMS BA 200 device.

The two training programs were implemented on the study sample, as the programs included exercises using the Tabata and CrossFit methods, and were distributed over the training units. In light of theoretical studies and scientific references, the time of the two programs was determined as follows:

- The duration of implementing the two programs (12) weeks.
- Program timing (during the special preparation period).
- Number of training units per week (3) units.
- Training unit time (90) minutes.
- Total number of training units (36) units.

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- The total time of the two programs (3240) minutes.
• Time distribution of the components of the training unit for each method:-
• Introductory part (10) minutes.
• Main part (70) minutes (physical 20 minutes + skill 30 minutes + complex 20 minutes).
• Final part (10) minutes.
• The two programs are implemented using Tabata and CrossFit exercises during the physical and complex preparation period of the training unit.
• The Tabata training program included exercises (squats, push-ups, jump rope, and running in place)
• The CrossFit training program included exercises (battle roping, continuous, fast, and gradually increasing difficulty plyo-soft box exercises using all parts of the body with diversification in the exercises, and skill training on foot movements)

It was also taken into account that the intensity used in the training simulates the conditions of a football match, which requires fast running, performing sudden movements, and jumps with maximum intensity, in addition to jogging and walking, as the intensity of the exercises used on the Burke scale ranged between (6-9 degrees), which is equivalent to the load in intensity (high to very high). **(William & Adams, 2014)**

The pre-test was conducted before implementing the exercises, and after the end of the specified period of twelve weeks, the post-test was conducted for both experimental groups. To obtain the research results, the statistical package (SPSS) was used through the laws of the arithmetic mean and standard deviation and the (t) test for independent and non-independent samples.

Results

Table (1) shows the arithmetic means and standard deviations of the variables under study in the results of the pre- and post-tests of the first experimental group (Tabata training).

The first experimental group (Tabata training)							
Search variables		The pretest		Post test		t	Sig. (2-tailed)
		Mean	Std. Deviation	Mean	Std. Deviation		
functional variables	anaerobic capacity	5.4209	.20186	7.6893	.46164	-14.544-	0.000
	Heart rate	146.8000	5.73101	160.4000	4.06065	-5.412-	0.000
	Vo2 max After the effort	30.6775	.53537	38.9638	1.06310	-21.995-	0.000
biochemical variables	HB	14.0300	.33682	14.4200	.27406	-3.683-	0.005
	HCT	40.1000	1.37032	43.0000	2.00000	-6.018-	0.000
	RBC	5.1275	.01729	5.2088	.06418	-3.408-	0.008
	Lactate Dehydrogenase LDH	355.3700	3.91182	503.8800	33.68349	-14.312-	0.000

From Table (1) it shows the arithmetic means of the differences, standard deviation, error level (sig) and significance of the differences between the pre- and post-tests. The results show that the value of the error level (sig) is smaller than the value (0.05), which indicates that there are significant differences between the pre- and post-tests in favor of the post-test, as shown in Figure (1).

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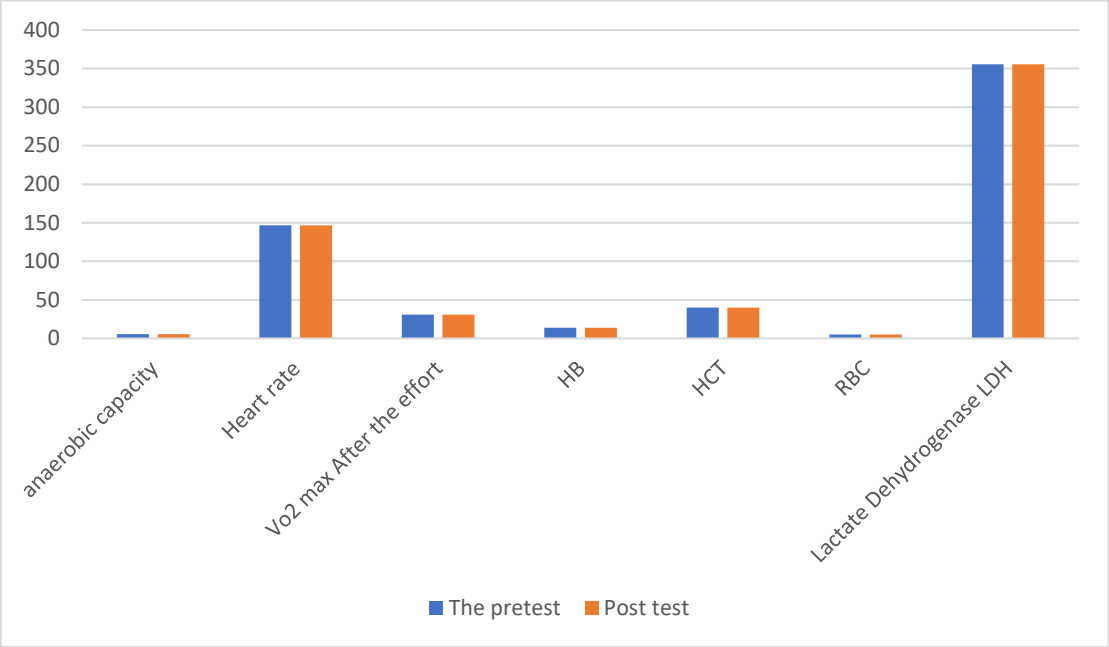

Figure (1) shows the arithmetic means and the difference in arithmetic means between the results of the pre- and post-tests of the first experimental group (Tabata training) in the functional and biochemical variables.

Table (2) shows the arithmetic means and standard deviations of the variables under study in the results of the pre- and post-tests of the second experimental group (CrossFit training).

The second experimental group (CrossFit training)							
Search variables		The pretest		Post test		t	Sig. (2-tailed)
		Mean	Std. Deviation	Mean	Std. Deviation		
functional variables	anaerobic capacity	5.2822	.57667	8.4619	.64809	-13.122-	0.000
	Heart rate	147.1000	6.82235	164.5000	2.87711	-7.114-	0.000
	Vo2 max After the effort	31.1524	1.46306	41.4868	1.42290	-26.933-	0.000
biochemical variables	HB	13.9800	.31552	14.7100	.26013	-5.508-	0.000
	HCT	40.1000	1.10050	45.3000	.82327	-10.614-	0.000
	RBC	5.1200	.01840	5.3473	.06441	-12.198-	0.000
	Lactate Dehydrogenase LDH	354.2700	3.34599	543.9500	31.11464	-19.206-	0.000

From Table (2) it shows the arithmetic means of the differences, the standard deviation, the error level (sig) and the significance of the differences between the pre- and post-tests. The results show that the value of the error level (sig) is smaller than the value (0.05), which indicates that there are significant differences between the pre- and post-tests in favor of the post-test, as shown in Figure (2).

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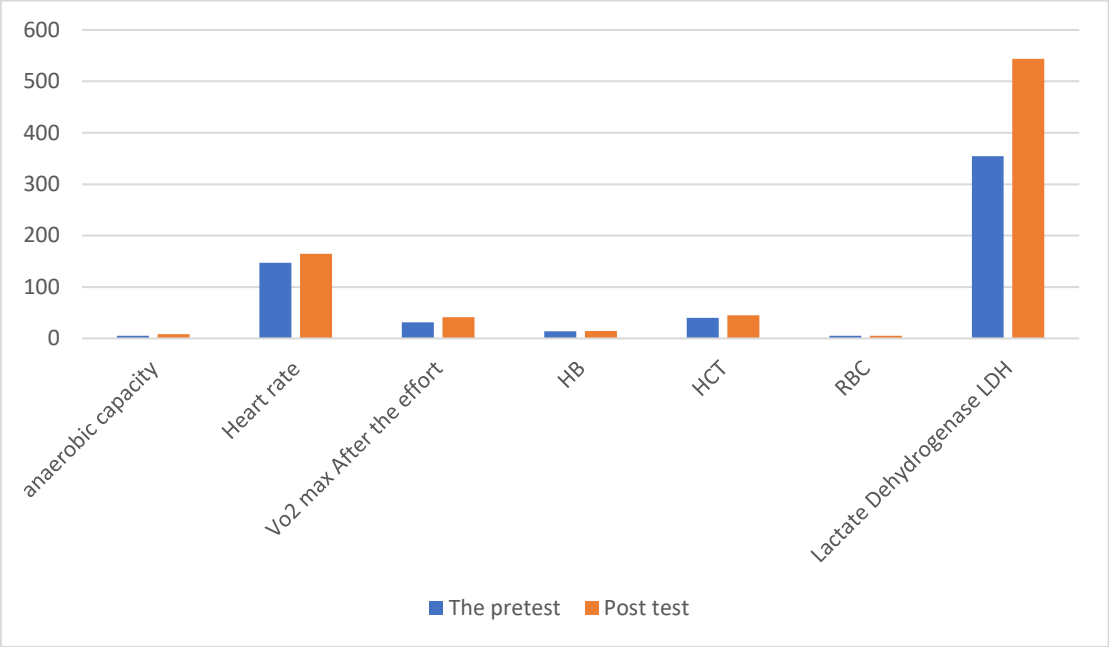

Figure (2) shows the arithmetic means and the difference in arithmetic means between the results of the pre- and post-tests of the second experimental group (CrossFit) training (in the functional and biochemical variables

Table (3) shows the arithmetic means and standard deviations of the variables under study in the results of the post-tests of the two experimental groups

The two experimental groups							
Search variables		**The first experimental group (Tabata training)**		**The second experimental group (CrossFit training)**		**t**	**Sig. (2-tailed)**
		Mean	**Std. Deviation**	**Mean**	**Std. Deviation**		
functional variables	anaerobic capacity	7.6893	.46164	8.4619	.64809	-3.070-	0.007
	Heart rate	160.4000	4.06065	164.5000	2.87711	-2.605-	0.018
	Vo2 max After the effort	38.9638	1.06310	41.4868	1.42290	-4.492-	0.000
biochemical variables	HB	14.4200	.27406	14.7100	.26013	-2.427-	0.026
	HCT	43.0000	2.00000	45.3000	.82327	-3.363-	0.003
	RBC	5.2088	.06418	5.3473	.06441	-4.817-	0.000
	Lactate Dehydrogenase LDH	503.8800	33.68349	543.9500	31.11464	-2.763-	0.013

From Table (3) it shows the arithmetic means of the differences, standard deviation, error level (sig) and significance of the differences between the post-tests. The results show that the value of the error level (sig)

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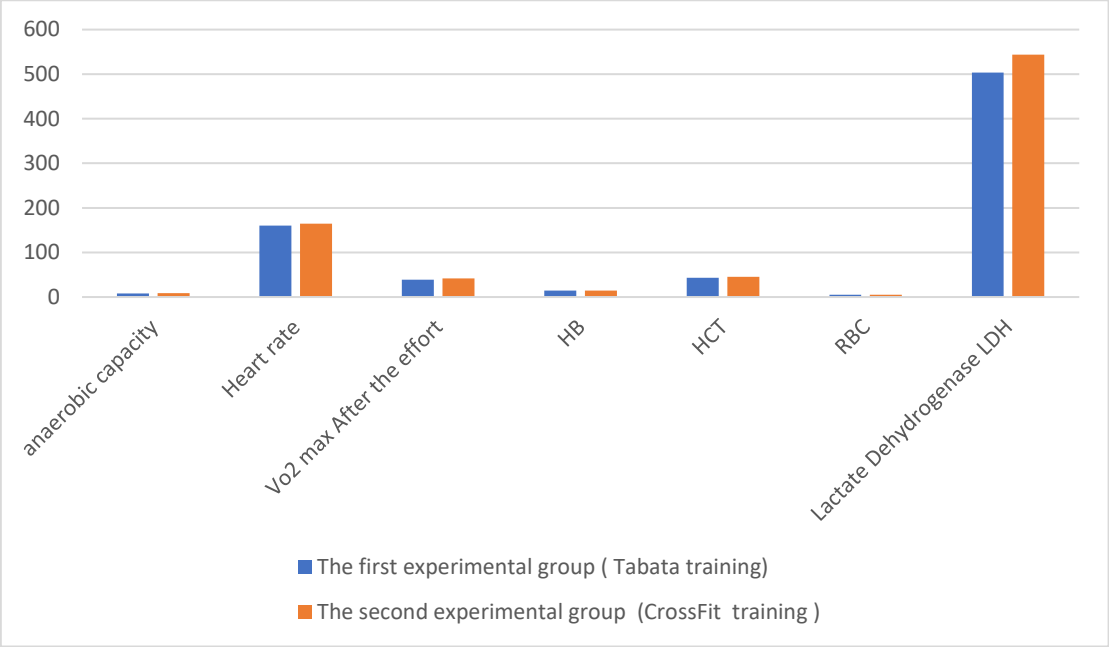
is smaller than the value (0.05), which indicates that there are significant differences between the post-tests in favor of the second experimental group, as shown in Figure (3).



Discussion

The table shows a comparison between two experimental groups (Tabata training and CrossFit training) using a set of functional and biochemical variables. A detailed discussion of the results is provided below:

Functional variables:

1. Anaerobic Capacity:

The Tabata training group showed a lower mean (7.6893) compared to the CrossFit training group (8.4619). The difference was statistically significant at the (Sig = 0.007) level, indicating that CrossFit training was more effective in improving anaerobic capacity. This may be explained by the fact that the nature of CrossFit training includes diverse and intense exercises that lead to increased anaerobic endurance. **(Moran ,et al, 2017)** stated that CrossFit training is one of the latest training methods that aim to develop the physical and physiological capabilities of athletes, as it includes a variety of exercises that are performed in a circular manner, which helps improve health-related fitness variables such as aerobic capacity, muscular endurance, and body composition. This may give competitors fun and excitement to improve their psychological state, which increases motivation among competitors during training and reduces the chances of injury, which in turn is reflected in raising the level of performance in competition. The nature of CrossFit also includes exercises of various intensity and duration, which enhances anaerobic endurance **(Glassman, 2002).** CrossFit training includes a variety of different exercises that start with warm-up exercises, then the trainee moves to the most prominent exercises such as abdominal exercises, chin-up exercises, weightlifting exercises, aerobics and gymnastics. These exercises are practiced repeatedly without stopping or resting for the duration of the specified training unit. When the person reaches the levels, he moves to the advanced levels, i.e. the trainee practices what is known as the four times. This means that the person tests four exercises to practice them for a specific number and for a specific period, such as practicing plyo soft box exercises five times, then swapping rope five times, then practicing running exercises for ten times, then step exercises for ten minutes, and so on,

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in addition to squatting exercises with jumping in the air, which works to increase muscle strength, increase joint endurance and develop the player's anaerobic capacity **(Oğuzhan Yüksel, et al, 2019)**

2. Heart Rate:

The Tabata group showed a higher heart rate (160.4) compared to the CrossFit group (164.5) The difference was statistically significant (Sig = 0.018), indicating a difference in the body's response to the two trainings. The researchers attribute this to the fact that Tabata relies on short, high-intensity intervals, which leads to a noticeable increase in heart rate. This was confirmed by **(Paoli et al)** that high-intensity training, as in Tabata, leads to a temporary increase in heart rate, while CrossFit adapts the heart to work at higher levels for long periods **(Paoli, et al., 2012).** Researchers attribute these differences to the fact that CrossFit heart rate training relies specifically on a set of compound movements that take into account the cardiovascular effort with shorter, high intensity. Therefore, researchers used these muscle-directed exercises to provide these muscles with functional movements and high intensity that are fundamentally more effective in achieving the desired level of physical fitness. This is the difference between Tabata training and CrossFit training.

3. VO2 Max after exercise:

The VO2 Max value for the Tabata group was lower (38.9638) compared to the CrossFit group (41.4868), with a statistically significant difference (Sig = 0.000).

The explanation for this is that CrossFit is based on compound exercises that require higher oxygen consumption, which leads to greater improvement in aerobic capacity **(Feito, et al, 2018).**

(David Kell, 2019) states that CrossFit training has gained immense popularity around the world as a sport that develops the physiological aspects of players, as studies have shown a significant improvement in the maximum oxygen consumption and a decrease in the percentage of body fat as a result of using a standardized CrossFit training program. **(Amal Sabih ,2019)** adds that CrossFit programs are the fastest-spreading and most widely practiced training programs, as they are practiced in 142 countries around the world due to the diversity of the training program content and their benefits in improving the physical efficiency of the elements of respiratory endurance, muscular endurance, muscle strength, flexibility, speed, coordination, balance and accuracy. The exercises are performed in a circular manner. The exercises are performed at high intensity according to the player's level, with reduced rest periods between groups. The modern trend in sports training is towards training the energy production systems for each game according to the contribution of each energy production system in any game, as Fox confirms that in football, for example, the oxygen energy production system contributes about 70% of the total energy expended, i.e. Most of the energy produced by the player in football, as well as in most team games, is due to insufficient oxygen in energy production, which constitutes the largest proportion of the total energy consumed during matches. Since this system constitutes the largest proportion in energy production, attention must be paid to developing this system and increasing its capacity by allocating a large training volume. **(Katelyn E., et al, 2016)**

CrossFit is a training system characterized by flexibility in choosing the type of exercises selected in a single training unit in a manner that suits the capabilities of the group practicing the program, which ultimately falls into one mold, which is not to deviate from the three training classifications specific to CrossFit, which are (gymnastics - cardio - weights).

Biochemical variables:

1. Hemoglobin (HB):

The mean hemoglobin was higher in the CrossFit group (14.71) compared to the Tabata group (14.42), with statistical significance (Sig = 0.026).

2. Hematocrit (HCT):

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An increase in the hematocrit ratio was also observed for the CrossFit group (45.3) compared to the Tabata group (43.0), with a statistically significant difference (Sig = 0.003).

3. Red blood cell count (RBC):

The RBC values were significantly higher in the CrossFit group (5.3473) compared to the Tabata group (5.2088), with statistical significance (Sig = 0.000).

Researchers attribute that physical exertion causes changes in the blood as it does for any other organ in the body, and these changes are of two types, some of which are temporary, i.e. changes that occur temporarily in response to physical activity and then the blood returns to its state at rest, and some of which are relatively continuous, which are changes that occur in the blood as a result of regular exercise for a certain period, which leads to the blood adapting to physical exercise. These changes include an increase in blood volume, hemoglobin volume, and red blood cells, "since the concentration of blood accompanying physical activity often occurs as a result of a decrease in plasma volume, which means that blood cells and proteins, which represent the largest part of blood volume, have become more concentrated in the blood, and the concentration of blood in this case leads to an increase in the concentration of red blood cells, and this increase may reach 25%, which increases the value of hematocrit and may reach 50% without an equal increase in the number or contents of red blood cells in the blood, and the increase in the concentration of red blood cells leads to an increase in the oxygen capacity of the blood. **(Saad Kamal, 2003)** These results may also be due to the fact that aerobic exercise Anaerobic training, as in CrossFit training, leads to an increase in the secretion of concentrated red blood cells from the spleen and bone marrow in response to the requirements of physical effort with an increased need for oxygen, which is in the hemoglobin of red blood cells, which explains the need to increase the secretion of these concentrated cells. As a result of these two reasons, the blood viscosity coefficient increases and thus the hematocrit level in the blood increases, as the blood's tendency to clot in the veins and arteries in the body increases to increase the concentration of the blood. **(Kamal Abdel Hamid, Abu Al-Ala Abdel Fattah, 2001)** The reason for the lack of oxygen in the blood during physical exertion affects the kidney, which secretes a substance called renal factor, and also affects the liver, which secretes a substance called globulin. These two substances react in the blood to form the hormone EPO erythropoietin, which is carried through the blood to the red bone marrow, affecting the cells that produce red blood cells, stimulating them to produce large numbers of red blood cells. As a result of this increase in the number of red blood cells, the amount of oxygen carried by the blood returns to its normal state, after which the secretion of these two substances decreases. As a result of the increase in the number of red blood cells, an increase in the amount of hemoglobin in the blood occurs during physical **exertion (Smith, Michael, et al, 2015)**

4. Lactate dehydrogenase (LDH):

The mean LDH was higher in the CrossFit group (543.95) compared to the Tabata group (503.88), with statistical significance (Sig = 0.013).

The reason for the high LDH levels indicates an increase in anaerobic glycolysis as a result of the high effort in CrossFit, as continuing physical performance when performing CrossFit training requires rebuilding ATP through the ATP rebuilding systems, which are the anaerobic system (phosphagocyte, lactic) and the aerobic system. Since the intensity adopted in performing some CrossFit exercises is sub-maximal intensity (90%), and with time periods ranging between (45-120) seconds, therefore, the reliance is on rebuilding ATP to continue meeting the body's energy needs to the anaerobic system (phosphate, lactic), after exhausting the creatine phosphate stock, the body then begins to rely on rebuilding ATP on the anaerobic breakdown of glucose through a series of reactions that end with the formation of lactic acid by the enzyme (LDH), as "lactic acid is produced from the breakdown of glycogen and glucose by some enzymes that work to break down glucose into lactic acid as the end of the process (glycolytic pathway) with the help of the enzyme Lactate dehydrogenase)) which works to convert (Pyruvate) to (Lactic). **(Bahaa El-Din Ibrahim, 1990)** Pyruvate

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turns into lactic when oxygen is low anaerbic condition, as in muscles Or when there is a large muscle activity where pyruvate is reduced to lactate by NADH and the enzyme lactate dehydrogenase (LDH) and when there is a large muscle activity the amount of oxygen in the muscles is very small so that it cannot quickly reach the mitochondria to oxidize the NADH produced by the glycolytic pathway. In this case, lactate dehydrogenase of the type (LDH - M4) source of the muscles converts a high amount of pyruvate to lactate **(Saad Kamal Taha, Ibrahim Yahya, 2003)**

From the above, the results show that both training (Tabata and CrossFit) have a positive effect on functional and biochemical variables, but it seems that CrossFit training was more effective in improving aerobic and anaerobic performance as well as improving functional and biochemical variables. This can be explained by the nature of CrossFit, which combines strength, aerobic and anaerobic exercises. CrossFit training included exercises that varied between weight training, football training and aerobic training that were chosen as a result of analyzing the needs required by the study in terms of energy production systems and working muscles, the most important of which are clean, jerk, squat, deadlift, pull up, bench press, push press, hand stand, and various trunk exercises. Conclusions

The results showed a relative superiority of CrossFit training in improving functional and biochemical variables, indicating its effectiveness in improving aerobic and anaerobic performance as well as supporting physical endurance and increasing physiological values associated with athletic performance. Tabata training is also suitable for improving anaerobic efficiency and increasing heart rate quickly. In light of the results, the researchers recommend the use of CrossFit and Tabata training in developing functional, biochemical and physical variables, and that integrating the two training methods may provide comprehensive benefit. It is necessary to familiarize trainers with the method of performing these exercises, while emphasizing the need to conduct studies similar to the current study using other physiological and biochemical variables on different samples and different sports events.

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